SECTION 261850

MEDIUM VOLTAGE ELECTRIC MOTORS

PART 1 – GENERAL

101. GENERAL REQUIREMENTS

101.1 All medium voltage electric motors provided by the CONTRACTOR shall be in accordance with this section. The sections below outline basic motor design parameters in selection of medium voltage electric motors.

101.2 The CONTRACTOR shall verify the following parameters are included in the design of medium voltage electric motors:

a. Environment

b. System voltage, frequency and phases

c. Running horsepower requirements along with starting requirements and limitations

d. Special duty cycle requirements

e. Motor type and construction, rotor maximum allowable temperatures

f. Power factor, efficiency

g. Service factor

h. Speed and direction of rotation

i. Insulation type, corona tapes, volts per mil, mica tapes & other details

j. Temperature limitations of winding insulation and enclosures

k. Enclosure

l. Bearing construction and lubricating requirements

m. Noise level for motor and motor driven equipment assembly

n. Termination provisions for power, control, grounding and accessories

o. Installation, testing, maintenance and operating requirements

p. Accessories and special features (space heaters, temperature monitoring, etc.)

q. Starting method and starting current requirement

r. Thrust load, if required

101.3 The CONTRACTOR shall submit the following documents in accordance with Section I – Contract Drawing and Data Requirements, to the DISTRICT for review:

a. Motor nameplate data for all motors shall be include horsepower, service factor, insulation class, speed, full load current, locked rotor current, frequency, voltage and maximum ambient temperature for which motor is designed per NEMA standards.

b. Outline dimension drawings of motors showing overall dimensions, shaft height, terminal box location, dimensioned conduit entrance to terminal box, shaft float, shaft diameter at coupling end, grounding provisions, mounting details, base or sole plate details and name plate information. The drawing shall include terminal box details and connection information for all applicable motor accessories such as stator resistance temperature detectors (RTD), space heaters, bearing RTDs and vibration monitoring pick-ups.

c. Electrical schematic (elementary) drawings, showing all individual components and interlocks and functionally in agreement with logic diagrams shall be supplied. The schematics shall be complete and show inputs required from and outputs available to the Purchaser and shall include equipment numbers. The use of a symbol to denote an assembly of electrical items (black boxes) is not acceptable for relay control circuits unless the schematic for that assembly is submitted. All device identifications and wire numbers shall be consistent with associated wiring drawings

d. The motor datasheet shall include:

d1. Motor type, frame size, rated voltage, voltage variation, frequency, frequency variation and rated speeds.

d2. The starting and thermal withstand times at 90%, 100% and 110% rated voltage.

d3. Power factor at starting, 25%, 50%, 75% and 100% load.

d4. Efficiency at 25%, 50%, 75% and 100% load.

d5. Space heater quantity, wattage rating, voltage, phase and frequency

101.3 Rating:

a. The motor nameplate horsepower rating shall not be less than 115% of the brake horsepower required by the driven equipment when operating at design conditions, and not less than 100% of the brake horsepower required to operate the driven equipment at its maximum requirements. The motor service shall be 1.0.

b. Motors shall be designed for full voltage starting and frequent starting and shall be suitable for continuous duty in the specified ambient. Intermittent duty motors are not permitted. Motors shall be sized for the altitude at which the equipment will be installed.

101.4 Motor Voltage Ratings

	Motor Drive Ratings	Control		Heaters
Size	250 hp and above			As Required
Voltage	6,900 V	120 VAC	125 Vdc	120V or 480V
Phase	3	1	N/A	1

101.5 Except as specified otherwise, the torque characteristics of all induction motors at any voltage from 80 percent rated voltage to 110 percent rated voltage or the starting conditions indicated herein shall be as

required to accelerate the inertia loads of the motor and driven equipment to full speed without damage to the motor or the equipment.

102. TECHNICAL REQUIREMENTS

102.3 Design and construction of each medium voltage motor shall be coordinated by the CONTRACTOR with the driven equipment requirements and shall be as specified herein.

102.4 Medium Voltage Motors:

Each motor shall be designed and constructed in accordance with the following requirements:

a. Squirrel-cage induction type with copper rotor bars

b. Voltage: 3-phase, 60 hertz

c. The motor enclosures shall be weather protected Type II. All air intake and discharge openings on the weather protected motor shall be protected with corrosion-resistant metal guard screens with 1/4 in. intake and 3/8 in. discharge mesh. The motors shall be supplied with two sets of permanent type inlet filters and 3/8 in. pipe connections to which a portable manometer can be connected to measure the pressure drop across the filters. All filters shall be supplied with a permanent embossed stainless steel identification plate identifying the associated motor. An air pressure switch shall be provided to alarm on high differential pressure in the ventilating system

d. Ambient temperature: see Site Design Data, Section 011900.

e. Windings shall be vacuum pressure impregnated (VPI).

f. Split sleeve bearings shall be provided

g. Bearing lubrication shall be via oil rings self-cooled (forced cooled if required)

h. The solid shaft shall be fabricated of a corrosion-resistant material or furnished with corrosion-resistant treatment.

i. Stator and rotor windings shall be of copper and copper alloy.

j. The motor enclosures shall be weather protected Type II. All air intake and discharge openings on the weather protected motor shall be protected with corrosion-resistant metal guard screens with 1/4 in. intake and 3/8 in. discharge mesh. The motors shall be supplied with two sets of permanent type inlet filters and 3/8 in. pipe connections to which a portable manometer can be connected to measure the pressure drop across the filters. All filters shall be supplied with a permanent embossed stainless steel identification plate identifying the associated motor. An air pressure switch shall be provided to alarm on high differential pressure in the ventilating system..

k. Starting voltage of 80 to 110 percent rated voltage

l. The motor shall be furnished with steel soleplates and stainless steel shims.

m. Suitable lifting lugs shall be provided for lifting motors during installation and for maintenance purposes. Each motor shall have a set.

n. The motor shall be furnished with the following temperature detectors for connection to the DISTRICT's DCS and protective relays:

n1.1 Bearings shall be provided with 100-ohm platinum, dual-element, RTDs

n1.2 Winding temperature detectors, 100 ohm platinum RTD, two per phase shall be provided.

102.5 Nameplates:

a. All motor nameplate data shall conform to ANSI Standard C50.41 requirements.

b. All motor nameplates and attachment pins shall be stainless steel.

102.6 Service Factor:

a. All medium voltage motors shall have a service factor of 1.0.

b. The motors shall be designed to provide a continuous horsepower capacity equal to the rated nameplate horsepower without exceeding the total limiting temperature rise stated in these specifications for the insulation system and enclosure specified.

102.7 Vibration Sensors

The motors shall be provided with mountings for vibration sensing equipment in the horizontal and vertical directions at each bearing to facilitate mounting of vibration sensors. Location of flat areas to facilitate mounting of vibration sensors for pumps shall be in accordance with ANSI/HI. Provisions shall also be made for a flat on the axial direction. See Section 409119 for sensors requirements.

102.8 Insulation and Windings:

a. All insulated windings shall have Class F non-hygroscopic sealed insulation systems, VPI.

b. The winding temperature rise by resistance for all motors shall be 80°C (Class B) in conformance with ANSI C50.41 for a 1.0 service factor motor.

c. All insulated winding conductors shall be copper. Aluminum windings are not acceptable.

d. The insulation resistance of the entire winding, corrected to 40°C, shall not be less than motor rated kV+1 megohms for all windings.

102.9 Space Heaters:

a. All medium voltage motors shall have space heaters. Space heaters shall be rated 240 volts for operation on 120 volts, or single-phase, 60 Hz or 480V,as necessary. Space heater leads shall be stranded copper cable with 600 volt insulation and shall include terminal connectors.

b. Space heaters shall be sized as required to maintain the motor internal temperature above the dew point when the motor is idle. The internal temperature shall not cause winding temperatures to exceed rated limiting values nor cause thermal protective device "over temperature" indication when the motor is not energized.

102.10 Terminal Housings:

a. All medium voltage motors shall be provided with Type I terminal housings that are oversized 40% by volume. See ANSI C50.41 Table 5.

b. Separate accessory terminal housings provided for current transformer secondary leads, temperature detector leads, space heater leads, alarm device leads, and other similar accessory equipment leads shall be complete with screw type terminal blocks. Each terminal block shall be labeled for identification.

102.11 Leads:

a. All leads, including power leads, temperature detector leads, and space heater leads, shall be wired into their respective terminal housings. All leads and their terminals shall be permanently marked in accordance with the requirements of ANSI Standard C50.41. Each lead marking shall be visible after taping of the terminals.

b. All motors shall have the direction of rotation marked by a corrosion resistant metallic arrow mounted visibly on the stator frame near the terminal housing or on the nameplate. The leads shall be marked for phase sequence T1, T2, T3, to correspond to the direction of rotation and supply voltage sequence.

102.12 Ground Connectors:

a. Each motor shall be furnished with a grounding connector attached to the motor frame inside the power lead terminal housing. The grounding connector may be a lug or terminal or other acceptable grounding connector. Grounding connector size shall be according to NEC requirements.

b. Each motor shall have two additional grounding connectors permanently attached to each end of the motor frame. The grounding connectors shall be copper pads with drilled and tapped holes suitable for attaching two-hole NEMA grounding lugs.

102.13 Motors shall have sufficient turn-to-turn insulation strength (3.5 p.u.) to be able to withstand the voltage impulses that occur when the motor is energized or de-energized without the use of surge protection capacitors at the motor terminals and surge arresters. The motors shall meet the surge withstand requirements shown in IEEE-522 Figure 1, 3.5 per unit test voltage value 0.1-0.2 msec. Turn-To-Turn Insulation Testing shall be per IEEE-522.

102.14 Bearings:

a. Sleeve bearings on horizontal motors shall be designed and located centrally, with respect to running magnetic center, to prevent the rotor axial thrust from being continuously applied against either end of the bearing. Motors shall be capable of withstanding, without damage, the axial thrusts that are developed when the motor is energized. Limited float couplings shall be furnished with sleeve bearing motors.

b. Motors furnished with sleeve bearings shall be furnished with air gap measurement holes or other acceptable means for checking the air gap. The bearings, end bells, and bearing housings shall be split type.

c. Thrust bearings for vertical motors shall be capable of operating for extended periods of time at any of the thrust loadings imposed by the specific piece of driven equipment during starting and normal operation without damage to the bearing, the motor frame, or other motor parts.

d. The horizontal-type motor shaft with sleeve bearings shall be scribed to show its magnetic center when operating at its full-load rated speed, and a suitable reference point shall be indicated on the bearing housing.

102.15 Oil Lubrication Systems:

a. Each motor furnished with oil lubricated bearings shall be furnished with oil rings. Oil rings shall be of one-piece construction. The internal systems furnished for vertical motors shall include oil reservoirs for the bearings.

b. Where a self-cooled bearing lubrication system is required, oil reservoir capacities and ventilation of the bearing housings and oil reservoirs shall be as required to maintain proper cooling of the oil and bearings under the maximum ambient temperature conditions specified.

102.16 Miscellaneous Bearing Requirements:

a. All bearing mountings shall be designed to prevent the entrance of lubricant into the motor enclosure or dirt into the bearings and shall be provided with pipes and drain plugs. Bearings shall be designed to be re-lubricated easily.

b. All oil-lubricated bearings shall be provided with provisions to check the oil level when running or at standstill (i.e., sight glass).

c. Insulation shall be provided when required to prevent circulation of shaft current on bearings, on bearing temperature detector connections.

d. Oil sample ports shall be provided for motor lubrication reservoirs with a capacity of 5 gallons or greater. On circulating lubrication systems there shall be a sample port located on the pump suction line prior to any inline filtration. On non-circulating lubrication reservoirs the sample port shall be located at a level 2/3 from the bottom of the reservoir to the running full lubrication level.

e. Grease-lubricated bearings, if applicable, shall have a single shield and zerk fitting with reliefs.

102.17 Torque Characteristics:

a. Except as specified otherwise, the torque characteristics of all induction motors at any voltage from 80 percent rated voltage to 110 percent rated voltage or the starting conditions indicated herein shall be as required to accelerate the inertia loads of the motor and driven equipment to full speed without damage to the motor or the equipment.

b. Torques for normal torque (NT) motors shall not be less than 80% of full load torque at rated voltage and frequency for locked rotor and pull-up torque and 200% for breakdown torque. High torque (HT) motor torques will be in accordance with Table 2 of ANSI C50.41-2000 as a minimum and higher if required for proper operation.

c. Pull-Up Torque and Breakdown:

The torque of the motor shall be 10% above the load torque requirement throughout the entire speed range at 80% of motor-rated voltage, 200% breakdown torque as a minimum. Requirements for pumps shall be met when operating with cold water (Specific Gravity = 1.0); and for fans when operating with cold air (Air temp = -23°F). The motors safe stall times shall exceed the start time for all conditions, both hot and cold.

d. CONTRACTOR shall be responsible for matching the motor speed-torque curves with the driven equipment speed-torque curves for all specified accelerating conditions and maximum load conditions. A composite curve with load and motor torques on the same curve shall be provided.

e. Hot Thermal Limit Requirements (High Inertia Loads, i.e. fans):

The allowable hot thermal-limit time for locked-rotor, at any starting voltage, shall be greater than the time required to accelerate to rated speed at that starting voltage to allow sufficient room to set and coordinate the protective relay curves for the motor.

f. Hot Thermal Limit Requirements (Low Inertia Loads):

The allowable hot thermal-limit time for locked-rotor, at any starting voltage, shall be at least 3 seconds greater than the time required to accelerate to rated speed, at that starting voltage.

102.18 Bearing Babbitt

a. Horizontal motors shall be supplied with labyrinth type split sleeve type insulated bearings. The design shall permit bearing replacement without removing the bottom bearing bracket.

b. Sleeve bearings shall have a babbitt material meeting Federal Specification QQ-T-3900, SAE Type II, Grade 2.

c. Motor bearings shall have their own lubrication system. Lubrication shall be of the self oil ring type. 120V immersion heaters are required. Forced lubricated bearings shall also have oil rings.

d. Bearings shall be insulated to protect against the damaging effects of shaft currents. Each bearing housing shall be insulated. Bearings shall be interchangeable.

e. Thrust bearings on vertical motors shall have a babbitt material meeting Federal Specification QQ-T-3900, SAE Type II, Grade 2.

102.19 Motor Differential Protection:

a. Motors 1500 hp and larger shall be provided with differential protection.

b. Each phase conductor on neutral end shall have a CT for DISTRICT to use for a true current differential relaying. Neutral current transformer (CT) ratio shall be determined by Engineer after notice to proceed. Accuracy lower than C400 will not be acceptable.

c. Phase current transformers on the neutral end of the motor shall be provided by CONTRACTOR for connection to DISTRICT's protective relay. Leads shall be wired to a terminal box accessible for DISTRICT's cable connection.

103. TESTING

Each motor shall be tested in accordance with the latest edition of IEEE Standard 112 and Table 1-1.

TABLE 1-1
REQUIRED FACTORY TESTS

Test	Comments / Explanation / Test Result

Test	Comments / Explanation / Test Result
Factory Tests	
Measurement of winding resistance (IEEE 112-2004 Section 4.2.2 & IEEE 118-1978 when measuring the resistance of stator windings & the rotor winding on wound rotor machines.)	Self-Explanatory Basic Requirement
No load readings of current, power and nominal speed at rated voltage & frequency (IEEE 112-2004 Section 4.21.1, 4.1.5, 4.1.6 & 4.3.2)	Self-Explanatory Basic Requirement
Mechanical vibration (IEEE 112-2004 Section 8.6 & NEMA MG-1-2000 Part 7)	Self-Explanatory To confirm the standards requirement for vibration have been met. Acceptance values vary between the indicated standards.
Direction of rotation vs. phase sequence	Self-Explanatory Basic Requirement
Insulation resistance (IEEE 112-2004 Section 8.1 & IEEE 43-2000)	Self-Explanatory Insulation Value
High-potential tests (IEEE 112-2004 Section 8.2 & IEEE 43-2000)	Self-Explanatory Insulation Integrity
Determination of locked rotor (zero speed) torque & current. (IEEE 112-2004, Section 7.2)	Self-Explanatory Basic Requirement
Determination of speed-torque curve. (IEEE 112-2004, Section 7.3.)	Self-Explanatory Basic Requirement
Temperature Tests. (IEEE 112-2004, Sections 4.4, & 5 3).	Self-Explanatory. To confirm the motors meet the Standard listed requirements.
Determination of full-load current & slip. (IEEE 112-2004, Sections 4.3.2, 5.3.1,4.1.5, 5.9.5)	Self-Explanatory Basic requirements, establishes the parameters.
Determination of efficiency at 100%, 75% and 50%. (IEEE 112-2004 Sections 6,6.1,6.2,6.2.1 through 6.9)	Efficiency is often looked at in the evaluation process & is often called out in the procurement specification. The test can be done in many ways & those methodologies are outlined in the listed Standard.
Determination of power factor at 100%, 75% and 50%. (IEEE 112-2004, Section 5.1 1)	Power factor is an important characteristic & affects power consumption as does efficiency & needs to be established as a reasonable design parameter.

END OF SECTION 261850